

Engineering and Safety Requirements for Student Projects

1. Listed as additional requirements for:
 - a. Tools (Float Sample Grabber, Surface Sampling Device, Rock Chip Sampling Device)
 - b. Test Beds (Asteroid Simulant for Rock Chip Sample, Asteroid Simulant for Core Drill Sample)
 - c. Requirements that apply to both Tools and Test beds
2. Tools
 - a. All tools must have a tether loop which will allow the astronaut to use a tether with hooks (similar to a carabiner hook) to restrain the tool
 - b. All tools must be operable with EVA gloved hands (like heavy ski gloves)
 - c. Tools must not have holes or openings which would allow/cause entrapment of fingers
 - d. Hydraulic Power Requirements
 - i. The following fluids are approved for use in hydraulic systems:
 1. Water
 2. Biodegradable Food-Grade Hydraulic Oil ISO Grade 32/46, SAE Grade 20, McMaster-Carr part# 3499K22
 - e. Pneumatic Power Requirements
 - i. Student projects will be allowed to connect to the NBL's compressed air (shop air) system:
 1. Pressure: 125 psig
 2. Connector details: **To Be Supplied**
3. Test Beds
 - a. Test Beds must be stable during use on the floor in a 1-G environment (i.e. does not need additional support)
 - b. Test beds should allow transport to/from the pool deck via a forklift, if required
 - c. Test beds shall include shackle or lift point features to allow lifting the hardware into/out of the pool and restraining the testbed in the pool
 - d. Lifting - Lift points yield strength Factor of Safety = 4

4. Both

- a. Environmental Condition - NBL Pool Use:
 - i. A totally submerged condition in water that contains a range of 0.5 to 3.5 parts per million of free chlorine
 - ii. Ambient temperature range: +82° F (27.8° C) to +88° F (31.1° C)
 - iii. It is anticipated that some of the projects will be tested on the pool floor at a depth of 40 feet
- b. Acceptable materials for use in the NBL
 - i. Allowable materials: typical engineering metal alloys (e.g. stainless steel, aluminum, titanium), plastics, composites, or soft good materials are acceptable for short term testing in the pool.
 - ii. Allowable lubricants, coatings, foam, or adhesives are shown in Attachment 1
 - iii. Other materials (e.g. gels) must be approved for use in the pool
- c. Sharp Edges and Protrusions
 - i. Because of the potential for personal injury to diving support personnel and damage to the EVA suit, the mockup components shall not contain sharp edges and items capable of cutting or puncturing items coming into contact with them
 - ii. Avoid (or protect the handler from) pinch points and/or sharp edges
 - iii. The hardware shall be designed to specify manufacturing to remove burrs, break all sharp edges and round all corners
- d. Water Entrapment - Mockups and hardware shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool
- e. Labels - The hardware provided shall have labels as follows:
 - i. Mate/de-mate alignment marks, operation indicators, as required
 - ii. Caution and warning tags for Hazard areas (i.e., pinch points, sharp edges, etc.).
 - iii. Hardware identification
 - iv. Additional safety labels may be requested by Test Readiness Review (TRR).
- f. Loads – the hardware must withstand normal handling or kickloads and not present a safety hazard

ATTACHMENT 1 – NBL MATERIAL LISTS

Material Designation	Manufacturer
DOW Polystyrene Highload 60 Grade Blue Foam (64 lb/ft ³ buoyancy)	Ryder Insulation Corporation
Last-A- Foam (20 lb/ft ³ buoyancy)	General Plastics Mfg Corporation

Table 17: NBL Approved Foam Material List

Product	Suggested Vendors
Carboline 139 (Paint)	Carboline Company
Carbomastic 15M500 and 890	Carboline Company
Dupont 25P	Briggs Weaver
Ethone M-0-N (Marking Ink)	
Ethone M-5-N (Marking Ink)	
Ethone M-9-N (Marking Ink)	
Hi-Solids Catalyzed Epoxy	The Sherwin-Williams Company
NSP 120	NSP Specialty Products
Plasite 7122 (Paint)	Wisconsin Protective Coatings Corp.
UT Plast Super (non-epoxy)	UTP Welding Technology

Table 19: NBL Approved Coatings Material List

Product	Suggested Vendors
3M Adhesive Sealant Fast Cure 5200	N/A
3M Spray Adhesive	N/A
Dexter 0151 Hysol Epoxi-Patch Structural Adhesive	N/A
GE Translucent RTV 108 Silicone Rubber Adhesive Sealant	N/A
Labels: Thermatab Markers, THT-107-423	BRADY Worldwide 1-800-537-8791 www.bradyd.com

Product	Suggested Vendors
Loctite 608 Hysol Epoxi-Patch Adhesive	N/A
Plexis MA 422 FRP adhesive	N/A
PVC Heavy Duty Cement.	N/A

Table 20: NBL Approved Miscellaneous Items

Material Designation	Manufacturer
Braycote 601	Castrol Specialty Prod.
Braycote 602	Castrol Specialty Prod.
Braycote 803RP	Castrol Specialty Prod.
Christo-lube MCG-117	Lubrication Tech. Inc.
Halocarbon 25-10M	Halocarbon Corp.
Halocarbon 25-20M	Halocarbon Corp.
Halocarbon 25-5S	Halocarbon Corp.
Halocarbon 25-5SI	Halocarbon Corp.
Halocarbon 27S	Halocarbon Corp.
Halocarbon X90-10MS	Halocarbon Corp.
Krytox 280 AC	Dupont
Kyrtox 240 AC	Dupont
LOX-8	Fluoramics Inc.
Lubricant / Tef-Gel PTFE 9002-84-0	Ultra Safety Systems Inc.
Mobil – 28	Mobile
SAF-T-EZE	SAF-T-EZE Div, STL Compound Corp
Tiolube 460 Dry Film Lubricant	Tiodize Co., Inc., Huntington Beach, CA
Tiodize Type II (Titanium Hard Coat)	Tiodize Co., Inc., Huntington Beach, CA
Tiodize Type IV (Tiodize Type II plus Tiolon X40 Teflon coating)	Tiodize Co., Inc., Huntington Beach, CA

Table 21: NBL Approved Lubricants